SUPPLY RESPONSE TO COUNTERCYCLICAL PAYMENTS AND BASE ACRE UPDATING UNDER UNCERTAINTY: AN EXPERIMENTAL STUDY

CHRISTOPHER R. MCINTOSH, JASON F. SHOGREN, AND ERIK DOHLMAN

We design an experiment to simulate how people make agricultural production decisions under three policy scenarios, each incorporating direct payments (DPs): (*a*) price uncertainty without countercyclical payments (CCPs); (*b*) price uncertainty with CCPs; and (*c*) price uncertainty, CCPs, and uncertainty regarding base acreage updating. Results are the CCP program and perceived possibility of future base updating created incentives for subjects to invest more in program (base) crops, despite payments being decoupled from current production decisions. Those choosing to reduce revenue risk by increasing plantings of base crops may face reduced incomes, suggesting the efficiency of crop markets may be diminished.

Key words: base acreage, countercyclical payments, experiments, risk.

The 2002 Farm Security and Rural Investment Act contains two features that added complexity to farmers' planting decisions, and may have introduced new incentives that make cropping decisions based partly on potential government payments, rather than expected market returns. These are (*a*) the prospect of earning *countercyclical payments* (CCPs) on the farmer's endowment of historically produced *base crop acreage* when prices of these crops fall below pre-established levels; and (*b*) the option for farmers to update the allocation of base crops—from which direct payments (DPs) and CCPs are made—to reflect recent (1998–2001) production history.[1]

These Farm Bill changes have positive and negative effects. For farmers, the upside is reduced uncertainty and revenue risk. Farmers' concerns over uncertain *ad hoc* supplemental payments (given during 1998–2001 crop years to enhance payments in the 1996 Farm Bill) are alleviated by "institutionalizing" a subsidy program of CCPs through 2007 (Westcott, Young, and Price 2002). The base acre updating option provided flexibility for farmers who wanted to change the mix and amount of the different program crops eligible for subsidies for 2002–2007. The disadvantage is that both CCP and updating can cause a farmer to plant more base crop regardless of market conditions, leading to an inefficient allocation of resources (see Orden 2002; Miller, Barnett, and Coble 2003; Westcott 2005; Young et al. 2005). Although CCPs would be made on the basis of historic, not current, planting decisions, observers recognize that risk-averse producers may face incentives to continue producing their base crops as a strategy to minimize revenue risk and variability. In this event, producers may align current plantings with their base acreage even when their price expectations

[1] "Base acreage" refers to a farm's crop-specific acreage of wheat, feed grains, cotton, rice, oilseeds, or peanuts eligible to participate in commodity programs under the 2002 Farm Act. Base acres and yields determine the level of government (direct and counter-cyclical) payments and reflect a farm's historical level of acres and yields. Under the 1996 Farm Act, production flexibility contract (PFC) acreage and payment yields for most producers were generally based on—as in prior legislation—the crop mix and prevailing yields during the 1981–1985 period. The 2002 Act allows farmers to update this mix by (*a*) adding newly eligible crops (i.e., oilseeds) to their current mix, or (*b*) revising base acreage to reflect plantings during 1998–2001. We refer to "farmers" or "producers" assuming they own the base acreage.

indicate that higher (current year) returns could be earned by growing an alternative (nonbase) crop.[2] As for base acreage updating, farmers' current production choices may be influenced by their expectations of how each crop will be treated under future legislation. If they expect an updating option, they may plant for base to increase their expected future subsidy eligibility.

As a result, CCPs and the base acreage updating option under the 2002 Farm Act have potential supply response implications. The two open questions we address in this paper are: (*a*) By increasing the lower bound on income when the base crop is planted, do CCPs cause farmers to shift investment toward the base crop and blunt price signals from nonbase crops?[3] (*b*) Does the possibility of updating base acres cause farmers to continue or enhance their plantings of program crops in an attempt to secure future income from program payments?[4] We examine these questions by designing a lab experiment on how producers with heterogeneous risk preferences allocate resources under three cases: (*a*) a baseline of price uncertainty without CCPs; (*b*) price uncertainty with CCPs; and (*c*) price uncertainty with future policy uncertainty. We assess how cases (*b*) and (*c*) affect income and markets relative to the baseline.

Our results support some of the criticisms of CCPs and base acre updating. We find that with CCPs, laboratory decision makers increased their investment in the base crop relative to the baseline case. Adding updating and policy uncertainty, they continued to rely relatively more on the base crop than under a more policy-neutral environment. The implications of increased base acre plantings are several: lower potential income to producers who choose to reduce their revenue risk; decreased efficiency of crop markets due to distorted allocation decisions; depressed base crop prices, which further reduces income; and an increased likelihood of subsidy payments.

Overview of 2002 Farm Act Commodity Provisions

The 2002 Farm Act employs three primary methods to provide income support to field crop producers (principally wheat, feed grains, cotton, rice, and oilseeds): direct payments (DPs), CCPs, and marketing loans. Marketing loans and DPs were also available under the 1996 Farm Act, while the target-price system of CCPs represents the reintroduction—in modified form—of deficiency payments, which were eliminated by the 1996 Farm Act. Although this article focuses on the impact of CCPs and the base updating option, we briefly summarize the main features of each program to review the different sources of market income and program payments available to eligible farmers. We also summarize the options to establish and update base acres and yields, on which direct and CCPs are made.[5]

Direct Payments

Under this program, eligible farmers entering into an agreement with USDA receive annual fixed DPs during 2002–2007. Similar to the annual production flexibility contract (PFC) payments made under the 1996 Farm Act, DPs are based on a producer's historical production (base acres and yields) and are made (with some limitations) regardless of his or her current planting decisions or current market prices. The notable difference from the 1996 Act is that oilseed producers (e.g., soybeans, peanuts) became eligible. The payment equals a fixed payment rate for each crop multiplied by the payment acres (85% of base) multiplied by the DP historical yield.

Countercyclical Payments

CCPs are available to producers for covered commodities with base acres whenever the *effective price* for that commodity is below a predetermined *target price*. The per-unit payment rate for CCPs equals the amount by which the target price exceeds the effective price. The effective price equals the direct payment rate plus the higher value of (*a*) the market price or (*b*) the commodity marketing loan rate. Similar to DPs, CCPs are made regardless

---

[2] By "nonbase" crop, we take the farmer's perspective: crops for which the producer does not have a production history or an established base, or a crop ineligible for program payments.

[3] Planting a base crop ensures a higher minimum income received due to CCP subsidies and therefore can create an incentive for farmers to allocate crops such that they maximize their minimum possible revenue, usually called a *maximin* solution in decision theory.

[4] The more risk averse the person, the more likely they would engage in a maximin strategy or one that allows for a higher maximin earnings in the future (planting for or maintaining base).

---

[5] For a more detailed presentation of the main commodity policy provisions of the 2002 Farm Act, and a comparison with provisions available under the 1996 Farm Bill, see the ERS, USDA side-by-side analysis available on the ERS website at: http://www.ers.usda.gov/Features/FarmBill/Titles/TitleICommodities.htm.

of what crop the producer currently grows (with some limits). The amount of the CCP is equal to the payment rate for each crop multiplied by the payment acres (85% of base) multiplied by the CCP payment yield.[6] Similar to DPs, producers do not have to grow the base crop to receive CCPs, but unlike DPs, CCPs depend on current market prices for the base crop. If the effective price is above the target price, no CCP is received on the base crop.

Marketing Assistance Loans and Loan Deficiency Payments

Nonrecourse loans with marketing loan provisions operate as they did under the 1996 Farm Act, with some revisions to loan rates, and with eligibility extended to additional commodities (peanuts, wool, mohair, honey, pulses). Farmers must produce the covered program crop to be eligible for marketing loans. When market prices are below the loan rate, producers benefit from the program in two ways. First, farmers can repay the commodity loan at a lower "loan repayment rate" that reflects market prices. The difference between the initial loan and the amount repaid is the marketing loan gain. Second, a producer can opt not to take the loan and instead receive the marketing loan benefit directly by taking the difference between the loan rate and (if lower) the loan repayment rate as a loan deficiency payment (LDP).

Base Acreage and Base Update Option

The 2002 farm legislation allows farmers who received direct (PFC) payments during 1996–2002 to choose between keeping their old base acreage or updating base acres to reflect average planted acres for eligible commodities during the 1998–2001 crop years. Producers select one of the two options for all covered commodities. Although base yields for DPs still reflect yields during 1981–1985, producers who update their base acres to reflect 1998–2001 plantings have the option of updating yields on which CCPs are made. CCP yields are set at the higher of (a) 93.5% of average yields on planted acres during 1998–2001, and (b) average 1998–2001 yields plus 70% of the difference between program yields for PFC payments and average 1998–2001 yields.

Experimental Design: General Structure and Specific Elements

We designed the experiment to reflect the underlying incentives of the 2002 Farm Act. In the experiment, a participant allocated his or her acres into either a base crop or a nonbase crop, or both. We mimicked current planting choices by asking subjects to allocate a fixed number of *tokens* (i.e., acres) to a *Blue* option (base crop) and a *Red* option (nonbase crop).[7] For example, if a subject had 100 tokens, he might allocate 40 to Blue and 60 to Red, or in some other combination totaling 100.

Each subject's task was to allocate tokens under different experimental environments defined by economic and policy circumstances. Three cases were defined: (a) the *Baseline case:* price uncertainty with DPs only; (b) the *CCP case*: the baseline plus the potential of CCPs; and (c) *Policy risk case*: the *CCP case* plus policy uncertainty. Ten rounds were used for each case, giving a total of thirty rounds. This design allowed us to compare behavior in the *CCP case* and the *Policy risk case* against the *Baseline case* to better understand how CCPs and policy risk (including the possibility of mandatory base updating) affect behavior.[8] Consider each case in detail.

The Baseline case. We introduced the idea of DPs and price uncertainty. Direct payment rates are fixed for each base crop and are independent of current production and prices, i.e., decoupled (Westcott, Young, and Price 2002).[9] In the *Baseline case* (Case (a), each player faced the crop allocation choice and received an additional exogenous direct payment (BONUS1). Each crop came with

---

[6] For each crop, the CCP payment rate = (Target price) − (Direct Payment rate) − {Maximum [commodity price, loan rate]}.

[7] Following standard experimental procedures, we used context-neutral terms. Although farmers typically posses base acreage for several crops, we endowed the subjects with base acreage of one crop ("blue"). One can consider the other crop ("red") either a crop not eligible for government payments (a nonprogram crop) or a program crop the farmer had not previously planted. Because we exclude the marketing loan program, the "red" crop can be thought of as any nonbase crop.

[8] We control for order of play of the cases by using two sequences (called *treatments*): (a) *Baseline*, *CCP*, then *Policy risk case*; and (b) *Baseline*, *Policy risk*, then *CCP*.

[9] The 2002 Act provides DPs similar to the former production flexibility contract (PFC) payments. Direct payments are tied to base acreage, but are completely decoupled from a farmer's current planting choices and current market prices. We include DPs in the baseline case because, although not affecting current production decisions, they constitute one part of government payments that may be at risk if mandatory base updating is instituted (a possibility introduced in the *Policy risk case*). Recall that CCPs are also decoupled from production decisions, but are linked to current market prices of the farmer's base crops.

Table 1. Lottery Probabilities, Prices, Expected Values per Token, and Variances per Token Used in the Experiment

Lottery	Prob ZP	Prob LP	Prob HP	ZP	LP	HP	EValue/Token	Var/Token
			Program Crop (Blue)					
1	0.1	0.6	0.3	0	13	17	12.9	22
2	0.1	0.4	0.5	0	11	19	13.9	36
3	0.1	0.4	0.5	0	13	19	14.7	32
4	0.1	0.5	0.4	0	12	18	13.2	27
5	0.1	0.6	0.3	0	13	18	13.2	24
6	0.1	0.4	0.5	0	12	17	13.3	25
7	0.1	0.4	0.5	0	8	17	11.7	33
8	0.1	0.4	0.5	0	12	21	15.3	44
9	0.1	0.3	0.6	0	11	32	22.5	144
10	0.1	0.5	0.4	0	12	18	13.2	27
			Nonbase Crop (Red)					
1	0.1	0.55	0.35	0	12	18	12.9	26
2	0.1	0.4	0.5	0	12	21	15.3	44
3	0.1	0.5	0.4	0	10	28	16.2	101
4	0.1	0.4	0.5	0	11	23	15.9	60
5	0.1	0.4	0.5	0	10	24	16	72
6	0.1	0.4	0.5	0	13	14	12.2	17
7	0.1	0.5	0.4	0	10	14	10.6	16
8	0.1	0.5	0.4	0	13	15	12.5	18
9	0.1	0.5	0.4	0	18	23	18.2	42
10	0.1	0.3	0.6	0	14	15	13.2	20

Note: ZP = Zero price; LP = Low Price; HP = High Price; EValue = Expected Value; Var = Variance.

inherent price risk. Before a subject made an allocation decision, he or she knew that three price outcomes were possible (*Zero*, *Low*, and *High Price*) with given values and probabilities for each crop. After a participant allocated his tokens, two independent random draws determined the *realized Blue* and *Red prices*.[10] Over the ten rounds, we used ten lotteries that cover a range of expected values and variances for the Blue and Red crops. Tables 1 and 2 show the pattern.[11] We added this feature for two reasons: to cover a variety of base and non-base lottery decisions, and to give players distinct lotteries to keep them focused on earning more money, i.e., experimental *dominance*.[12]

The CCP case. We added the possibility of CCP payments to the *Baseline case*. In the 2002 Act, CCPs are determined by comparing a target price to the base crop price, and are based on the formula:

CCP payment rate

$$= \text{Target price} - [\text{Maximum \{commodity price, loan rate\}} + \text{Direct payment rate}].[13]$$

We fixed the target price minus the DP rate to be above the given *Low Price* and below the given *High Price*. In addition to the direct payment (BONUS1), this created two potential CCP subsidies. We presented these subsidies to the subjects as lump-sum bonuses: a bonus if *Zero* is the realized base crop price (BONUS2), and a smaller bonus if the *Low Price* is the realized base crop price (BONUS3). We incorporated the decoupled (from production) nature of CCPs as follows: if the realized base crop price is *Zero* or *Low*, then participants received the corresponding base crop bonus regardless of their current allocation of Red and Blue tokens. For example, if the *Low price* is realized, players receive BONUS1 and BONUS3 irrespective of how they allocated their tokens.

---

[10] These random draws made the prices of our crop options independent. With correlated prices, CCPs still provide maximin incentives for planting base crops.

[11] The inequalities (presented in Table 2) either within or across the lotteries are not necessarily the same numerically or by percentage; it is a general pattern.

[12] Dominance means here that the monetary rewards dominate the subjective costs of making choices in the experiment, or any other motivation.

[13] We isolated the impact of CCPs by assuming no marketing loan program.

Table 2. Lottery Expected Value/ Variance Test and Bonus Schedule for Each Lottery

Lottery	Expected Value	Variance	Bonus Schedule		
			BONUS1	BONUS2	BONUS3
1	Same	Blue < Red	150	1,350	50
2	Blue < Red	Blue < Red	150	1,350	250
3	Blue < Red	Blue << Red	150	1,350	50
4	Blue << Red	Blue < Red	150	1,350	150
5	Blue << Red	Blue << Red	150	1,350	50
6	Blue > Red	Blue > Red	150	1,350	150
7	Blue > Red	Blue >> Red	150	1,350	550
8	Blue >> Red	Blue > Red	150	1,350	150
9	Blue >> Red	Blue >> Red	150	1,350	250
10	Same	Blue > Red	150	1,350	150

The policy risk case. We introduced three potential policy outcomes to be realized after allocation decisions are made: (*a*) repeal of the CCPs (which recreates the *Baseline case*); (*b*) DPs and CCPs (which recreates the *CCP case*); (*c*) or people must update their base acres (for that round only) given their allocation in that round (this represents a mandatory base updating). If the mandatory updating policy is realized, the participant earned *Realized BONUSES* based only on the percentage of base crop planted. For example, if the subject chose fifty Red and fifty Blue with a realized Blue price of *Zero*, he or she earned total *Realized BONUSES* = [(50 Blue tokens)/100 total tokens] ∗ (BONUS1 + BONUS2); i.e., 50% of BONUS1 plus BONUS2.[14] A participant that updated was only affected in that current round; he or she started the next round with 100 (blue) base acres (each round therefore mimics the beginning of a new Farm Act).

---

[14] Note a caveat about our experimental design. We recognize our design has people making one-time decisions over many rounds. Our representation of a base acre updating policy does not reflect current legislation. The 2002 Act gave farmers the one-time option of updating base acres to reflect recent planting history and this base acreage is in effect for the remainder of the Farm Act. In the *Policy risk case*, if the updating policy was randomly chosen the participants faced a mandatory updating of their base acres based on the token allocation decisions made earlier that round. Current program benefits (bonuses) were potentially reduced for that round while base acres in subsequent rounds were unaffected (start with 100 base acres in each round). This is a simplification of the current Farm Act's updating procedure, in which base acres could have been changed based on average plantings of program crops during 1998–2001 (Westcott, Young, and Price 2002). While our design represents a potential policy for updating, it is a simplification of the potential range of future updating options, should they occur at all. Attempting to include updating based on current policy would have greatly complicated the current design without necessarily providing much additional insight.

Experimental Design: Specifics

We conducted the experiment in a computer lab at the University of Wyoming with approximately twenty-five terminals. Each session had a varying number of subjects. Students entered the room, and sat down at a private computer terminal. The computer program employed has four useful features. First, the moderator can select the maximum round time, prices, probabilities, bonuses, round order, case order, and between fixed outcomes or random draws based on specified probabilities. All the results are based on random draws. Second, round earnings were privately displayed to the subject after a decision, and random draws determine the realized prices in each round. Third, subjects could view their own allocations, earnings, and cumulative earnings in previous rounds for a given *case*, including when making their current allocation decisions. Fourth, subjects could use the *Decision Tool*. The Decision Tool is a calculator, given the subject's preliminary allocation of Blue and Red, that could be used to determine the joint probabilities and earnings for each of the nine price combination possibilities (e.g. Blue *Low Price*/Red *High Price*, etc.). The Decision Tool also showed the total expected value and variance of that choice.[15]

Our specific design followed two stages— measuring risk preferences (*X*-test) and individual decision making under risk.[16] This two-stage experiment served to examine how people with heterogeneous risk preferences

---

[15] Using the Decision Tool was optional. As in the wilds, subjects who understand expected value and variance may use such tools to help their decisions, while others need not.

[16] Experimental instructions can be found on-line at the *AgEcon Search* website, http://agecon.lib.umn.edu/.

make their production decisions facing price uncertainty with and without CCPs, and with and without policy uncertainty on base acre updating. Following standard experimental procedures, the first stage measured each participant's risk preferences by asking them to make choices over nine monetary lotteries.[17] This permitted us to classify subjects as risk averse, risk neutral, or risk loving and to explore whether risk preferences were associated with different behavior under each *case*.

After completing the risk preference questions, the subjects moved on to the main experiment with the *Baseline*, *CCP*, and *Policy risk* cases. The computer program provided a quick overview of the experimental instructions, informing subjects that earnings would be given in *lab dollars*, with a 2000 lab dollars to $1 dollar conversion rate. The *Baseline case* instructions were independently read followed by an ending quiz to test/help subjects better understand the instructions.[18] Each subject allocated their 100 tokens in each of ten rounds. Subjects had four minutes per round to make their allocation decision; if the limit was exceeded, he or she would receive zero earnings for that round (no subject exceeded the time limit in any round). Each subject faced the ten lotteries (see table 1) presented in random order.

After the *Baseline case*, about half the subjects participated in the *CCP case* for ten rounds and then the *Policy risk case* for another ten rounds; the other participants did so in reverse order. Again the instructions for each *case* were independently read, and quizzes administered.[19] After all thirty rounds were completed, the program displayed the results of the risk preference test (either the $2.50 sure bet or the realized lottery results), and then each

case-specific earnings, and finally, total earnings. The students were paid in cash and left the room. Total laboratory time varied between forty-five and ninety minutes; total earnings were between $18.85 and $36.06, with an average of $28.10.

Variable parameters. We had three key parameters that varied in value—price uncertainty, bonuses, and policy risk. For price uncertainty, each lottery was resolved as either *Zero*, *Low Price*, or *High Price*.[20] We used zero to emphasize the effects a CCP with a very low price on the base crop, and used a relatively low probability of realization (a constant 10%). The *Low Price* varied from 8 to 18 lab dollars and the *High Price* varied from 14 to 32 lab dollars, with probabilities for each ranging from 30% to 60% (see table 1).

The potential bonuses were presented as lump-sum payments.[21] We did this since base acreage did not change—subjects had 100 base acres in each round. The direct payment (BONUS1) was fixed at 1.5 lab dollars/Blue base acre (150 lab dollars for all 100 Blue base acres).[22] In the *CCP* and *Policy risk* cases, a fixed target price of 15 lab dollars/base acre was set for the base crop. Once the target price and DPs were fixed, the possible CCP payments were determined by:

(1)   BONUS2 or BONUS3

$$= (\text{Blue target price} - \text{Blue realized price}) * 100 - \text{BONUS1}.$$

If the realized base price was *Zero*, BONUS2 was set at 1,350 lab dollars. The *Low Price* CCP (BONUS3) adjusts so equation (1) is satisfied and varies between 50 and 550 lab dollars depending on the lottery (table 2).

In the *Policy risk case*, we assigned fixed probabilities to the likelihood of different policy outcomes to reflect policy uncertainty. We

Table 3. Descriptive Statistics of the Dependent Variable for Each Case

Case	Mean	SD	Min	Max	Cases	Skewness	Kurtosis
Baseline							
Blue proportion	0.4953	0.2916	0	1.00	880	0.009	2.0711
CCP							
Blue proportion	0.5245	0.31	0	1.00	880	−0.1059	1.8659
Policy Risk							
Blue proportion	0.5236	0.3071	0	1.00	880	−0.0577	1.966

used a 60% chance the policy would be the same as the *CCP case* (both DPs and CCPs available) and a 20% chance for each of (*a*) the mandatory updating outcome (in which both bonuses varied with the percent of base crop planted) and (*b*) the *Baseline case* outcome (maintaining DPs but dropping the CCP subsidies).

Data and Hypotheses

The data were generated by running the experiment on students recruited in Economics and Finance undergraduate classes. Eighty-eight students participated, which created a balanced panel data set with thirty rounds of play. Table 3 provides descriptive statistics of the dependent variable, which is the proportion of tokens allocated to the Blue (base) option over ten rounds in each case. Relative to the *Baseline case*, our (alternative) hypotheses are:

- Hypothesis 1 (H1)—subjects will be less responsive to price signals with the introduction of a CCP system;
- Hypothesis 2 (H2)—subjects will be less responsive to price signals (relative to baseline) under a system with CCPs and policy uncertainty (including potential mandatory base updating); and
- Hypothesis 3 (H3)—the effects of the CCP and policy uncertainty will be greater than without potential mandatory updating/policy uncertainty.

Hypothesis H1 follows because choosing to allocate resources to the program crop reduces downside risk. In the *CCP case*, a player allocating to the base crop (Blue) is guaranteed to receive at least the target price per token (15 lab dollars per token). In contrast, if he allocates to the nonbase (Red) crop and the *realized Red price* is *Zero* with a *realized High Blue price* (implying no CCP given), he receives only the direct rate per token

(1.5 lab dollars per token). Allocating tokens in the Blue option maximizes the minimum possible earnings per token, i.e., the maximin solution.[23]

Why might adding the option of revenue risk reduction influence production decisions? In the *Baseline case*, players were given lotteries and asked to choose to maximize expected net returns. In contrast, the CCP provides another option to be considered—revenue risk reduction. The producer's problem is transformed. A producer faces the joint optimization problem of balancing (*a*) maximum expected net return and (*b*) minimum revenue risk (see Westcott, Young, and Price 2002). At the individual level, a player placing more weight on revenue risk reduction allocates additional tokens in the Blue option. Westcott, Young, and Price (2002) note this individual expected return/revenue risk trade-off implies that aggregate equilibrium production levels would reflect both profit maximization and revenue stabilization.

Hypothesis H2 builds on the above discussion and includes policy uncertainty on CCP availability and possible mandatory base updating. In the *Policy risk case*, we have a 20% chance of DPs only, a 60% chance of DPs with CCPs, and a 20% chance of mandatory updating. Since the 20% DP-only is identical to the

---

[23] Consider the possibilities of the realized Blue prices: (*a*) If the price is the *High Price*, the participant receives the market price (at least 17 per token, see Table 1a) plus the direct rate (1.5 per token) which, in sum, is greater than the target price per token. (*b*) If the price is the *Low Price*, the participant receives the market price plus the direct rate plus BONUS 3 which, in sum, is the target price per token (1,500 total lab dollars divided by 100 tokens equals the target price of 15 per token). (*c*) If the price is the *Zero Price*, the participant receives a market price of zero plus the direct rate plus BONUS 2 which, in sum, is again the target price per token (1,500 total lab dollars divided by 100 tokens equals the target price of 15 per token). Thus the minimum received from a token allocated to the Blue option is the target price. The minimum possible earnings for investment in Red occurs when the realized *Zero* Red price and a realized *High* Blue price occur: (*a*) If the price is the *Zero Price* and the Blue price is *High*, the participant receives a zero market price plus the direct rate (1.5 per token) only (no bonuses when blue price > target price) which, in sum, is equal to 1.5 per token. Thus the minimum received from a token allocated to the Red option is the direct rate.

Baseline case, there should be no additional effect. The 60% DP-CCP is the same as the *CCP case*; so we expect more base acreage allocation. The 20% mandatory updating should also induce a subject to allocate more to the Blue option since potential subsidies are directly tied to the production decision. Since the combined probability of CCP and mandatory updating exceeds the DP-only case (80% versus 20%), we expect more tokens to be allocated to the base crop compared to the baseline.

For Hypothesis H3, the intuition on whether the effects of the CCP with updating and policy uncertainty will be greater than the *CCP case* alone is more intricate than the other hypotheses. The 20% DP-only bonus outcome should lead to less reliance on the base crop than the *CCP case*. The 60% chance of a DP and *CCP* bonus is a neutral outcome, with no expected difference compared to Hypothesis 2. The 20% chance of a mandatory updating outcome may induce more investment in the Blue option than the *CCP case* since any level of Red reduces potential subsidies. There are predicted positive and negative effects compared to the *CCP case*.

Our prediction is again based on the maximin solution. Policy uncertainty means a subject has a chance to earn nothing if he allocates all resources to the nonbase crop. This occurs if the realized policy was mandatory updating and the nonbase realized price was *Zero*. Since all plantings are in the nonbase, no subsidies are available. While this outcome has a low probability (2%), the possibility of receiving zero lab dollars in a single round may create movement toward the base crop. The only way to avoid this risk is to continue to invest in the base crop, which is a maximin strategy. We know in the *Policy risk case* the only way to guarantee a minimum income of at least the DPs (the minimum per round earnings in the *CCP case*) is to invest all tokens in the base option.[24]

Model

We explore the panel data allocation choices using a random-effects model:[25]

$$PBlue = \alpha + \beta_1 T2_i + \beta_2 CCPcase_{it}$$
$$+ \beta_3 Policyriskcase_{it}$$
$$+ \sum_{j=4}^{12} \beta_j Lottery_k + \beta_{13} LDCE_{it}$$
$$+ \beta_{14} LHITIND_i + \beta_{15} RAVER_i$$
$$+ \beta_{16} RLOV_i + \varepsilon(i, t) + u(i)$$

For $i = 1 - 88, k = 2 - 10, t = 1 - 30$

where *PBlue* is the proportion of tokens each player allocated to the Blue option (base crop) each round and is presented in decimal form. Now consider our covariates. The constant term reflects the *Baseline case*, *lottery one*, and risk neutral players. Because lottery one should induce a higher proportion of blue investment (same mean with lower variance), we expect the constant to be positive. *T2* is the treatment (sequence) variable when players first faced the *CCP case* and then the *Policy risk case*. We do not anticipate a treatment effect. *CCPcase* and *Policyriskcase* are dummy variables for the rounds in which each player faces the *CCP* and *Policy risk cases*. Hypotheses H1 and H2 predict the β_2 and β_3 coefficients to be positive and significant. Hypothesis H3 predicts *Policyriskcase* to be larger in magnitude than *CCPcase*, $\beta_2 < \beta_3$. The *Lottery* variables are binary variables to capture the different lotteries (2 through 10 in table 1). We expected players to choose the lottery with the larger expected value, however, lotteries 3 and 7 are difficult to predict since the expected value is larger but the variance is much larger for the same option (higher risk).

LDCE is lagged dollar cumulative earnings.[26] Assuming players exhibit decreasing absolute risk aversion (DARA) preferences, we expect as players accumulate larger incomes they are more likely to move toward the nonbase (riskier) option (see, for example,

---

[24] Recall under the mandatory base update outcome, blue remains a program or base crop, and red remains ineligible for bonus payments.

[25] The Lagrange Multiplier test (*p*-value less than 0.005) indicated that random-effects model is preferred to the classic regression model (Greene 2000). The fixed-effects model cannot include the

treatment or the risk preference variables due to perfect colinearity with the individual intercepts. The Hausman test was conducted on the above model excluding T2, RAVER, and RLOV. The Hausman (1978) test (*p*-value of 1.00) indicated no significant difference between the fixed and random-effects models, which suggests that the random-effects model may be preferred since it is efficient (Greene 2000). The fixed-effects model yielded similar results with slightly lower case coefficients (0.0472 for *CCP case* and 0.0647 for *Policy risk case*) and lower significance levels (*p*-values 0.018 and 0.060). The two-way fixed effects model was not an option since there is perfect colinearity between the time periods and cases.

[26] This linear wealth term may be simple; we ran other specifications of wealth effects such as a squared term and interaction terms with the risk preference variables without improvement to the model.

Table 4. Random-Effects Regression Results

Variable	Predicted Coefficient	Coefficient	Std. Error
T2	Zero	0.0130	0.0152
CCPcase	+	0.0543***	0.0186
Policyriskcase	+	0.0792**	0.0311
LOTTO2	−	−0.235***	0.0224
LOTTO3	?	−0.130***	0.0224
LOTTO4	−	−0.234***	0.0224
LOTTO5	−	−0.185***	0.0224
LOTTO6	+	0.146***	0.0224
LOTTO7	?	0.0780***	0.0224
LOTTO8	+	0.170***	0.0224
LOTTO9	+	0.129***	0.0224
LOTTO10	−	−0.0798***	0.0224
LDCE	−	−0.00292*	0.00166
LHITIND	−	−0.0149	0.0317
RAVER	+	−0.0494*	0.0266
RLOV	−	0.0118	0.0249
Constant	+	0.537***	0.0208

Note: $N = 2{,}640$, $R^2 = 0.255$. A single asterisk (*) indicates significance at the 10% level, a double asterisk (**) indicates significance at the 5% level, and a triple asterisk (***) indicates significance at the 1% level. There was no statistical difference between one-way and two-way random-effects. Adding heteroscedasticity in either the general or group form did not lead to a significant difference in results. The autocorrelation coefficient was insignificant (estimated RHO = −0.056722) so no correction was made.

Chavas and Holt (1990), who report results supporting DARA preferences for corn and soybean plantings). *LHITIND* is lagged *hit* for an individual, in which we define a *hit* as when a player received a blue *High Price* and a red *Zero Price* in the same round, which eliminated the potential of either CCP subsidy (BONUS2 or BONUS3). This coefficient is predicted to be positive. Receiving a "hit" should push a player toward the maximin strategy in subsequent rounds in the *CCP* and *Policy risk case* by reminding participants of the risk reducing effects of planting the base crop. *RAVER* reflects those participants identified as risk averse; we expect risk aversion to induce greater allocations to Blue. *RLOV* indicates a risk-loving person, which should have a negative coefficient.[27] Table 4 displays the predicted signs for the coefficients.

[27] The risk-averse classification in the *X*-test was used for any player taking the $2.50 sure bet in all games, chose the sure bet in games 1–7, 1–8, or 1–9, or chose the sure bet in at least seven of ten games. A player was risk loving if they never took the sure bet, played the lottery in games 1–9, 2–9, or 3–9, or chose to play the lottery in at least seven of ten games. All players not in either of these two categories were considered risk neutral; this category contained a majority of the players.

Results and Discussion

Table 4 also shows the results of the random-effects model. The regression model is significant with an R-squared of 0.255. We see the constant term is positive and significant as predicted. We find no apparent treatment effect, T2. The lottery coefficients followed the pattern of subjects planting more acres in whichever investment option had the highest expected value. The lagged cumulative earnings variable *LDCE* indicates that as earnings increased, players chose a higher percentage of the nonbase option. This does not contradict the notion that players had DARA preferences, although the coefficient is significant only at the 10% level. *LHITIND* is insignificant, perhaps due to the paucity of "hits" in the data set.

The two risk-preference coefficients, *RAVER* and *RLOV*, are the opposite of the predicted signs, although both coefficients are relatively small and not significant at the 5% significance level. One explanation for the signs is that players may have not treated the two stages as independent; i.e., they tried to balance their portfolios of risk across the risk preference lotteries (i.e., the *X*-test) and allocation decision experiments. The *CCP case* and *Policy risk case* coefficients were the predicted sign and significant at the 1% and 5% levels. We now explore what the results suggest for our three hypotheses.

RESULT 1. We cannot reject (alternative) hypothesis H1: *Adding a CCP subsidy induced subjects to allocate more to the base option (Blue option).*

Support. We reject at the 1% significance level the null to hypothesis H1, which says that people are equally responsive to price signals for nonbase crops in the presence of a CCP-style subsidy compared with the *Baseline case*. The results suggest on average there was a 5.43% shift toward the base crop given CCP subsidies relative to the *Baseline case*, holding the other effects constant. The result is the CCP system dampened the responsiveness to market signals.

Result 1 has three economic implications. First, CCPs offer producers a way to reduce their revenue risk by following a maximin strategy. This can be perceived as a benefit to risk-averse producers. But there is also a potential cost. By planting more acres of base crops and giving less consideration to market

conditions for nonbase crops, producers might pass up opportunities to increase their revenue. CCP style subsidies may lower the incomes, over the longer term, of participating producers by creating risk-reducing strategies only for selected (base) crops.

Second, shifting production from base crops to nonbase crops affects markets for both crop types. Simplifying to a two-crop world, greater base crop production increases the supply and, holding demand constant, lowers the equilibrium price. If the new effective price exceeds the target price, no additional subsidies are provided and producers' per acre revenues from base crop production fall. But if the new effective price falls below the target price, the CCP partially compensates for the reduced market revenue (see the 2002 Farm Act). Also, assuming greater base crop allocation reduces nonbase crop production, the price for the nonbase crop increases. If the nonbase crop price exceeds the base crop price, a producer would have earned more revenue by planting the nonbase crop (assuming he or she is a price taker).

Third, the possible market effects have ramifications for government spending and trade. If producers switch from nonprogram to program crops so the supply of each program crop increases, program crop prices will fall (holding demand steady). As each program crop price decreases, the chance increases each individual program crop will qualify for CCPs, which increases government expenditures. Another issue is whether CCPs would be classified as "blue box" or production and trade distorting "amber box" domestic subsidies under World Trade Organization rules. Both spending categories are subject to limits under recent (October 2005) U.S. negotiating proposals and including CCPs in either category increases the possibility of exceeding WTO spending limits.[28]

Westcott (2005) points out that production distortion from CCPs may be "limited" in naturally occurring markets due to several factors. For example, farmers have other risk management tools at their disposal; large and less risk-averse farms tend to dominate production of program crops; and other programs such as marketing loan provisions already offer price protection. These factors underscore the difficulty of separating the effects of CCPs from other influences in observed annual

production data, a difficulty reduced when using experimental methods.

As noted by Roth (1995), experimental methods can provide rapid feedback to policy makers about issues that are not easily teased out with observed data. Roe and Randall (2002) further suggest that "the field of agricultural risk analysis could benefit . . . from continued research using experimental methods" in policy analysis. Our design isolated the CCP incentives under risk. Result 1 supports the idea that CCPs can be production distorting, as participants altered production choice toward planting more in the base crop. This result is supported by Anton and Le Mouel (2004) who find the risk reducing incentives of CCPs are significant as revealed by the estimated risk premia.

Our design did not address two features of the 2002 Act, which could affect the interpretation of our results. First, there are no adjustments made in our bonuses for the fact that direct and CCPs are made only on a percentage (85%) of base acres. If these adjustments were incorporated, the lump-sum bonuses would have been lower, implying our results could overstate the effects of CCPs. Second, we excluded the marketing loan program to focus on the basic CCP structure—target price, market price, and direct rate. Adding the marketing loan program into our design would temper the basic effects of CCPs by providing an additional price support mechanism.

Discussion of H2 Results

The impact of the base acre updating clause depends on expected benefits from future programs, which in turn depend on the continuation of such programs (Westcott, Young, and Price 2002). By introducing policy uncertainty (with the possibility of mandatory updating) along with CCPs, we examine how compounding these two risks affect production choices compared to our baseline, which we summarize as Result 2.

RESULT 2. We find evidence in favor of hypothesis H2: *A CCP style-subsidy program and policy uncertainty (with the possibility of mandatory base acreage updating) induced subjects to allocate more to the base option.*

Support. We reject at the 5% significance level the null to hypothesis H2 that people are equally responsive to price signals between crop (token) allocation choices in the *Policy*

---

[28] The United States has not yet notified the WTO of which category of domestic support CCPs would be placed.

risk case and the *Baseline case*. The coefficient suggests that there is an average increase of 7.92% toward investment in the base crop option in the *Policy risk case* compared to the *Baseline case*, holding all else equal. Introducing a CCP along with policy uncertainty, including mandatory updating, shifted crop allocation toward the base crop. The implications for the agricultural economy are similar to those discussed for *Result 1*.

The *Policy risk case* included both price and policy risk in a simplified setting, which created one key caveat. In our design, if the update option was realized, our players *had* to update (no choice to opt out). In reality, producers had the option not to update base acres in the 2002 Farm Act, and it is possible that the same could occur under future legislation. Most producers would likely use this "opt out" feature if it were added to our design, which implies less incentive to plant the base crop since the current design starts each participant with all base acres. Unless the player allocated all tokens to Blue (base), updating base would reduce per round earnings. If players never updated, the results should be indistinguishable from the *CCP case*.

Discussion of H3 Results

Another policy question is whether producers changed cropping strategies between the *CCP* and *Policy risk case*. Did mandatory updating cause them to ignore market signals and "plant to maintain base" in an attempt to maximize available subsidies? Result 3 suggests producers had a limited reaction to this policy risk.

RESULT 3. We find insufficient evidence to support hypothesis H3: *The coefficients of the CCP and Policy Risk case variables are not statistically different from each other.*

Support. We cannot reject at the 5% significance level the null hypothesis that the effects of the *CCP case* and *Policy risk case* are the same. The Wald test indicates that there is no statistical difference between the *CCP case* and *Policy risk case* coefficients (p-value 0.20). The lack of statistical evidence makes it challenging to disentangle the effects of policy uncertainty. Did participants not consider the change between the *CCP case* and the *Policy risk case*, or did the opposing effects of our policy uncertainty cancel out? Since the coefficients indicate the total effect with CCPs and policy uncertainty is probably at least as large

as with just the CCP, it is possible the incentive to plant the base (Blue) crop is stronger with mandatory updating despite the countervailing incentive created by the chance of policy elimination. This result suggests that participants were "planting to maintain base" (to secure future program payments). These participants disregarded current market signals to maintain or enhance program payments.

These results are similar to findings in Lusk and Coble (2003). Their experimental study had players make decisions over choices similar to our risk preference X-test, in which some of them faced an additional *background* mean-zero lottery. They tested for levels of risk aversion and found players who faced background risk were slightly more risk averse. Our results are adding policy risk on top of price risk induced incrementally more allocations to the base crop. Again this is a risk minimizing choice.

Conclusion

This study examined the production effects of *CCPs* and base acre updating under price and policy uncertainty in an experimental market. The experimental design allowed us to isolate how CCPs affect the mix of base and nonbase crops. The evidence suggests CCPs influence crop allocation decisions in the lab—the average player allocated more acres toward the base crop option relative to the absence of CCPs. The results were similar after adding policy uncertainty with a possibility of mandatory base updating. Our findings do not rule out nontrivial impacts to producers' planting choices, income, crop markets, and allocative efficiency.

Several extensions to our design could be considered. Mean-preserving spreads of prices and probabilities would test whether CCPs would have more impact on planting decisions. Understanding the extent of this impact would further clarify the key incentives affecting cropping decisions with available program payments. Second, one could examine how subjects react to more downside "hits" and how long it takes to recover from these shocks. Changing the *Policy risk case* probabilities could provide more insight into whether "planting to maintain base" occurs in the lab. A third extension is to allow for variable base acres and optional updating. Fourth, bankruptcy could be added, which would increase incentives to use a maximin

strategy. Finally, marketing loans and other risk-reduction options can be added to test the robustness of our results to a broader range of outside options.

References

Anton, J., and C. Le Mouel. 2004. "Do Counter-cyclical Payments in the 2002 US Farm Act Create Incentives to Produce?" *Agricultural Economics* 31:277–84.

Chavas, J.P., and M.T. Holt. 1990. "Acreage Decisions under Risk: The Case of Corn and Soybeans." *American Journal of Agricultural Economics* 72: 529–38.

Greene, W. 2000. *Econometric Analysis*. Upper Saddle River, NJ: Prentice Hall.

Hausman, J. 1978. "Specification Tests in Econometrics." *Econometrica* 46:1251–71.

Holt, C.A., and S.K. Laury. 2003. "Risk Aversion and Incentive Effects." *American Economic Review* 92:1644–55.

Lusk, J.L., and K.H. Coble. 2003. "Risk Aversion in the Presence of Background Risk: Evidence from the Lab." Working paper, Oklahoma State University.

Miller, J., B. Barnett, and K. Coble. 2003. "Analyzing Producer Preferences for Counter-Cyclical Government Payments." *Journal of Agricultural and Applied Economics* 35:671–84.

Orden, D. 2002. "Reform's Stunted Crop." *Regulation* 25:26–32.

Roe, B., and A. Randall. 2002. "Survey and Experimental Techniques as an Approach for Agricultural Risk Analysis." In R. Just and R. Pope, eds. *A Comprehensive Assessment of the Role of Risk in U.S. Agriculture*. Boston: Kluwer Academic.

Roth, A. 1995. "Introduction to Experimental Economics." In J. Kagel and A. Roth, eds. *Handbook of Experimental Economics*. Princeton, NJ: Princeton University Press.

Westcott, P. 2005. "Counter-Cyclical Payments under the 2002 Farm Act: Production Effects Likely to be Limited." *Choices* 20:201–05.

Westcott, P., C. Young, and J. Price. 2002. "The 2002 Farm Act: Provisions and Implications for Commodity Markets." ERS Agric. Information Bull. No. AIB778.

Young, E., D. Skully, P. Westcott, and L. Hoffman. 2005. "Economic Analysis of Base Acre and Payment Yield Designations under the 2002 U.S. Farm Act." ERS Economic Research Report Number 12.